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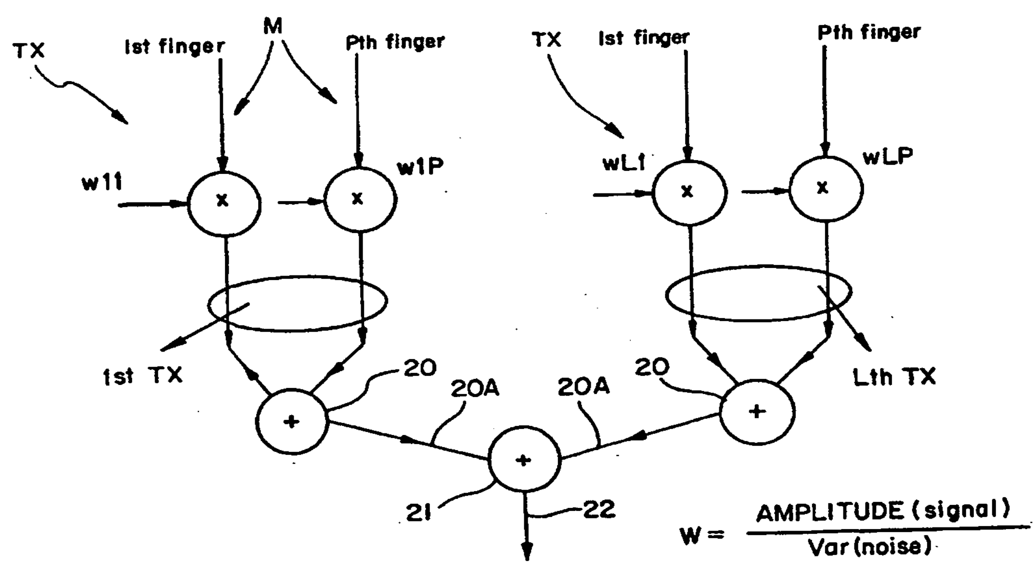

(57) Abstract

A "hybrid" ARQ system within a multiple access wireless communications environment is provided for recombining ARQ retransmission signals with information obtained from corresponding previously failed transmissions of the same signal which had been sent and received within the air interface. Forward Error Correction (FEC) is implemented within an ARQ environment by using whatever acquired information has been previously obtained from RAKE processed transmitted and retransmitted signals and trying to correct the information by combining the signals and without retransmission.

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RETRANSMISSION PACKET CAPTURE SYSTEM WITHIN A WIRELESS MULTISERVICE COMMUNICATIONS ENVIRONMENT

FIELD OF THE INVENTION

The present invention relates generally to wireless communication systems, and more particularly, to a system and method for correctly transmitting and re-transmitting data packets in a wireless multi-media communications environment.

BACKGROUND OF THE INVENTION

Various organizations worldwide are currently developing standards for the specification of the next generation of mobile telecommunications systems. Services offered by current wireless mobile systems are telephony and voice services supported by narrowband digital networks. There will be a demand for higher bandwidth services as more comprehensive data and information is transmitted. This comprehensive data will require mobile systems to interface with hardwired broadband networks using asynchronous transfer mode (ATM) transmission (defined below). Thus, today's wireless interface must carry narrowband services effectively while providing the flexibility to carry higher bandwidth services as the demand increases.

However, the harmonization of multiple communication services with different characteristics results in distinguishable spectrum and transmission needs. Representative services used on wireless communication networks include telephony, videotelephony, and high-speed data transmission. These services have varying and distinguishable needs which include being in high demand, being delay critical, requiring high bandwidth, and/or being intolerant of errors. These different services also have different encoding requirements, different error transmission requirements and different delay requirements. The trade-offs of these different requirements of the different services used on the network, when they are integrated into a single cohesive whole, lead to limitations in the ability of the network to transmit a large amount of information quickly, correctly and simultaneously.

The radio access technique most often utilized for these diverse requirements is known as code division multiple access (CDMA). CDMA and ATM characteristics, separately and in combination, offer significant advantages in wireless communication environments where a wide range of services must be carried. Both CDMA and ATM allow a transmission link to support a number of simultaneous connections which can be used on demand to simplify routing and reduce traffic congestion and overhead.

CDMA allows many users to share the same radio frequency spectrum simultaneously through the use of spread spectrum

transmission. Each individual connection across the radio interface is distinguished by a CDMA code allocated to that connection. Since there is a relatively large number of codes, they can be allocated to new connections as the connections are set up or when a new mobile station affiliates to a base station servicing multiple users. User data is transmitted over the air interface with an associated CDMA code and without the need for additional channel assignments. Thus, the CDMA code identifies the signal and represents a "virtual" channel connection for the air interface.

A reality of wireless communications is that data is communicated at essentially random times. Additional data may be added to the system and transmitted at any time. These random transmissions may, in the aggregate, force the system capacity to be exceeded and cause interference between users. These dynamically changing traffic characteristics may increase above system limitations and cause unacceptably excessive error rates.

ATM subdivides data for transmission into small fixed size packets called ATM cells which contain groups of information. Each ATM cell includes a data field and a control field which includes an address. The address within the control field can also be considered a virtual channel connection within a fixed network since multiple users are each identified by a separate address allocation. ATM is unlike traditional transmission

systems in that it is asynchronous, and only uses network capacity when there is data to be transmitted.

Another communications transfer mode known in the art is time division multiple access (TDMA). TDMA is similar to ATM, with the exception that TDMA is not asynchronous. Each TDMA transmitter sends a “cell” of information each time it is “polled.”

In mobile digital information transmission techniques, specifically CDMA, ATM and TDMA, data information is considered to be "bursty" in that significant amounts of data are reduced to "packets" and transmitted in "bursts." Burst mode transmission results in information packages being sent and packetization delays. The process of filling ATM cells with speech also involves packetization delays.

The inherent nature of radio communications, in terms of transmitter power constraints and limited spectrum availability, also restricts the maximum amount of information which is possible to be transmitted over an air interface. Thus, within an air interface, broadband communication services must be regarded as being similar to narrowband services due to the mobile power constraints and the limitations of the data transfer rate on the air interface network. Additionally, radio transmission is significantly more error prone than broadband hard-wired networks. This tends to further reduce capacity due to the necessity to transmit and process error control protocols.

The standard known in the art which was created by the International Telecommunications Union (ITU) for the wireless multimedia communications environment is known as IMT-2000. Figure 1 shows a graphical depiction of the various subsystems of a mobile radio station in conjunction with an associated base station within a multiple access environment under the IMT-2000 standard.

In Figure 1, the base station 12 includes a base station control 11 which controls the base station 12. The base station 12 communicates over a wireless interface 13 to a mobile station 14. The mobile station also includes a mobile station control 15. Each of the systems graphically shown in Figure 1 includes the following subsystems, an internal network 16, link access control subsystems 17, medium access control subsystems 18, and the physical radio air interface transmission system 19.

Current wireless communication of data, as used and as planned for implementation with IMT-2000, uses a system of error correction and reliability known as "Automatic Repeat Request" (ARQ). ARQ is a strategy of error correction which requests the re-transmission of a packet of data when the transmission is not completely and accurately received.

In ARQ, the receiver provides a signal to the corresponding data packet transmitter that the information data packet was not adequately received. Upon receipt of the ARQ signal, signifying an error in the previous transmission, the transmitter again re-transmits the data packet

to the receiver. This process is reiterated until the data packet is adequately received. The receiver is then able to receive the next data packet to be sent.

The ARQ process causes system delays as identical information is transmitted and retransmitted over and over again until the signal representing the data packet is deemed acceptable or is considered to have failed and the transmission of that information data packet is aborted. These retransmissions of identical information add unwanted network traffic causing system degradation and interference.

One system architecture utilized in wireless spread spectrum communications is known as pre-combining "rake." In this rake architecture, multiple path parameters for the received signal are derived from a downlink pilot signal and used for phase, amplitude, and time alignment of the various multiple path components which are combined prior to demodulation. Essentially, pre-combining rake recognizes that a single transmitted signal sent over a wireless communications link will have multiple components or "metrics" which must be combined by a receiver to obtain a single accumulated signal input for the Viterbi Algorithm, known in the art.

When the rake architecture is used within wireless communications systems, a transmission is deemed to fail when insufficient multiple path components are received and their combined power level is not above a predetermined threshold.

When the transmission fails, the rake receiver must undertake an error correction system. It transmits an ARQ request. The information signal is then re-transmitted by the transmitter. This process is reiterated until the signal is deemed to be adequately received, i.e., it is above the predetermined power threshold when rake recombination is completed.

However, the addition of multiple transmissions of the same signal adds unwanted traffic within the transmission network. Further, the rake system has power constraints due to multiple users on the network with different power availability. One user's transmission may interfere with the power level of another user's reception.

OBJECTS OF THE INVENTION

It therefore is an object of the present invention to provide an improved system for providing a wireless telecommunications system which will effectively carry narrowband services while providing the flexibility to carry higher bandwidth services.

It is a further object of the present invention to provide a wireless communications system which effectively addresses the differing wireless communications transmission and spectrum needs of multiple services (such as telephony, videotelephony, and high-speed data transmission), including being delay critical, requiring high bandwidth, and being intolerant of errors.

It is yet a further object of the present invention to provide a transmission system within a multiple access wireless communications environment which reduces unnecessary and unwanted information traffic on the network, reduces interference between users, addresses dynamically changing traffic characteristics in a way which provides for gradual degradation of system quality when network traffic limitations are exceeded and thereby reduces unacceptable communications errors.

It is still a further object of the present invention to provide a transmission system within a multiple access wireless communications environment which minimizes the necessary number of ARQ retransmissions of identical information in order to obtain an acceptable signal and thereby reduces unwanted information traffic from the wireless network.

SUMMARY OF THE INVENTION

These and other objects and advantages are achieved by the present invention by implementing a "hybrid" ARQ system within a multiple access wireless communications environment. The system recombines ARQ retransmission signals with information obtained from corresponding previously failed transmissions of the same signal which had been sent and received within the air interface. The present invention is considered to be "hybrid" ARQ in that it implements Forward Error Correction (FEC) within an ARQ environment by using whatever

acquired information it has already obtained and trying to correct the information without further retransmission.

The present invention recognizes that there is a trade-off between the number of ARQ transmissions within a network to obtain a single correct signal, and the interference caused by the re-transmission of the same signal over and over again until signal is correctly received. The present invention resolves this trade-off by processing the re-transmitted signal with the processed information already obtained from previously received corresponding signals which were transmitted and failed, i.e., they yielded an unacceptable resulting signal.

By combining corresponding re-transmissions, the present invention increases the likelihood that a successful transmission will be quickly achieved. The present invention recognizes that the probability of a successful transmission is geometrically increased as the number of correspondingly similar re-transmissions are combined to obtain a single correct signal. The combination of re-transmissions also allows the preferred embodiment of the present invention to minimize the number of likely re-transmissions necessary to achieve a successful signal being received, and thereby reduces the information traffic on the network. This further allows an increase in the number of users on the network without excessive degradation of the quality of transmission by the gradual increase in users.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, organization, advantages and objects of this invention will be fully understood from the following detailed description and the accompanying drawings. The drawings contained herein are not considered to be accurate depictions of the embodiments of the invention, but are provided for illustrative purposes only and are to be interpreted in conjunction with the attached specification.

Figure 1 shows a graphical depiction of the various subsystems of a mobile radio station in conjunction with an associated base station within a multiple access environment under the known IMT-2000 standard.

Figure 2 shows a graphical depiction of the algorithm used by the preferred embodiment to implement the system of the present invention.

Figure 3 shows a graphical block diagram depiction of the hardware configuration used to implement the method of the preferred environment of the present invention as shown in Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

The following description is provided to enable any person skilled in the art to make and use the invention, and sets forth the best modes presently contemplated by the inventor for carrying out this invention.

Various modifications, however, will remain readily apparent to those skilled in these arts, since the generic principals of the present invention have been defined herein.

The preferred embodiment of the present invention operates within a rake processing environment. The preferred embodiment determines when a first packet transmission is not adequately received by a transmitter. When the system determines that the first packet transmission is not adequately received, the receiver stores the resulting failed rake processed signal. An ARQ signal is then sent requiring retransmission of the signal by the transmitter.

The preferred embodiment then performs rake processing upon the second retransmitted signal. The system combines the previously stored first, failed, rake-processed transmission result with the corresponding second, rake processed retransmission result in an attempt to obtain an adequate signal. If the combined signal is still not adequate, the combined signal result is again stored, and the process is reiterated until a resulting signal is adequately obtained.

The preferred embodiment of the present invention reiterates the retransmission process until either (1) the resulting processed signal results in an adequate transmission being received, or (2) the system exceeds a default limitation of the number of reiterations allowed and the resulting failed signal is discarded. In the preferred embodiment of the present invention the maximum number of times, or reiteration threshold,

for allowable retransmission of data packets may be set on a per service basis. For example, a voice signal communication will have a lower reiteration threshold than high-speed data since each transmission error will have less of an affect on the outcome.

The preferred embodiment of the present invention determines if the rake processed received signal is acceptable by testing whether the processed signal has sufficient power to yield an error free result as an input for the Viterbi Algorithm. The system of the preferred embodiment of the present invention recognizes that the metrics of the transmitted signal take multiple paths across the air interface to the receiver. Due to this inconsistency in the paths of the multiple metrics of a single signal, the rake processing of the metrics may result in an unreliable signal being received. The preferred embodiment recognizes that the power level of the rake processed signal is a likely determinant of whether the signal is reliable in relation to the noise incurred across the air interface.

The preferred embodiment implements the present invention by combining transmitted and retransmitted signals based upon the following equation:

$$M_n(L) \circ M_n (L-1) + \Delta m_{n,L}$$

where: M is the accumulation of the soft decision bit metrics resulting from the rake processing of the transmissions, L is the number of the transmission within the multiple corresponding signals being

transmitted and retransmitted, n is the number of the bit within the data information packet being transmitted, Dm is the incremental, soft decision bit reception metric from the Lth, or last, transmission.

Figures 2 and 3 show a graphical depiction of the algorithm used by the preferred embodiment to implement the system of the present invention. As shown in Figure 2, each transmission TX is comprised of a series of metrics or fingers M. Each of these metrics M symbolizes a different one of the multiple path components of the transmission TX traveling across a different path over the air interface from a transmitter to a receiver.

The reliability of each metric M is determined based upon the path that it takes across the air interface. As shown in Figure 2, each metric M is weighted by a value W during rake processing to determine the potential value and reliability of its contribution to the result of the overall received signal TX which is to be included within the Viterbi Algorithm. In the rake processing of the metrics M, the weighted metrics M from a single transmission are processed and added together by adder 20 to produce a single resulting outcome 20A which is to be included within the Viterbi Algorithm.

As illustrated by Figure 2, each of the transmissions TX undergoes identical rake processing by the receiver. The preferred embodiment of the present invention further adds each of the raked signal outcomes 20A from each of the rake processed individual signals TX together through

adder 21 in order to obtain a total combined output signal 22. This output signal 22 is statistically a reliable representation of the transmission TX, based upon the rake processing of each of signals TX, and their rake combination together into a single reliable signal 22 which may be included within the Viterbi Algorithm.

Figure 3 shows a further graphical block diagram depiction of the hardware configuration used to implement the method of the preferred environment of the present invention as shown in Figure 2. Each of the metrics M is rake processed with its counterpart metrics M from each transmission TX.

As shown in Figure 3, the output representative 20A of each rake processed signal 20 is provided along the input 30. The input 30 is then fed into adder 31. The accumulated output 32 of adder 31 is sent to both memory 34 where it is stored and processor 33 where it is analyzed for processing within the Viterbi Algorithm.

If processor 33 determines that the processed transmission TX has been adequately received, then the representative signal of the transmission is used within the Veterbi Algorithm and sent along output 35 for further processing by the receiver. However, if the processor 33 determines that the output 32 is not an adequately useful signal, i.e., it does not have sufficient power to be representative of an adequate rake processed signal, then an output is sent along output line 36, and an ARQ signal is sent requiring further re-transmission from the transmitter.

The re-transmitted signal is received, rake processed, and the rake processed representative of the re-transmitted signal is again sent along input 32 to adder 31. The rake processed signal 30 is added by adder 31 to the previous accumulated rake processed results sent along line 37.

By implementing the shown system for recombining ARQ transmission signals with information obtained from corresponding previously failed transmissions of the same signal which had been sent and received across the air interface, the present invention is able to achieve a reduction in necessary traffic on a multiple access wireless communications network. The preferred embodiment of the present invention is further able to address the different transmission and spectrum needs of multiple services by reducing delay, addressing high bandwidth needs, reducing transmission errors, reducing interference and allowing for the gradual degradation of system quality when network traffic limitations are exceeded.

Those skilled in the art will appreciate that various adaptations and modifications of the just described preferred embodiment can be used and configured without departing from the scope and spirit of the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

What is Claimed Is:

1. A multiple access system of communication across a wireless interface comprising:

a transmitter for transmitting a signal representation of a packet of information and retransmitting the signal representation of the packet of information;

a receiver for receiving the signal representations of the packet of information; and

a means for processing the signal representations of the packet of information by combining the transmitted signals with the retransmitted signals to obtain an output signal representation of the packet of information.

2. The system of Claim 1 wherein the receiver sends an ARQ signal to the transmitter when the output signal is deemed to be unreliable, and the transmitter sends the retransmitted signal in response to the ARQ signal.

3. The system of Claim 1 wherein the receiver sends an ARQ signal to the transmitter when the output signal is deemed to be unreliable, and the transmitter sends the retransmitted signal in response

to the ARQ signal, the output signal being deemed to be unreliable when a default poser limitation is not exceeded.

4. The system of Claim 1 wherein the signal representations received by the receiver have multiple metrics and the processing means combines the metrics using rake processing.

5. The system of Claim 1 wherein the signal representations received by the receiver have multiple metrics and the processing means combines the metrics using rake processing to produce a resulting received representation of the signal representation of the packet of information.

6. The system of Claim 5 wherein the processing means combines the resulting received representations using rake processing to produce the output signal representation of the packet of information.

7. The system of Claim 6 wherein the processing means combines the resulting received representations from each successive retransmission of the signal representation with a previously accumulated rake processed representation of the signal representation to produce a new accumulated rake processed representation of the signal representation, and wherein the new accumulated rake processed representation is the output signal representation of the packet of information.

8. The system of Claim 7 wherein the signal representation of the packet of information is retransmitted by the transmitter until the output signal representation of the packet of information is deemed reliable.

9. The system of Claim 8 wherein the signal representation of the packet of information is retransmitted by the transmitter an amount of times until the amount of times exceeds a default limitation of the amount of times allowed.

10. The system of Claim 9 wherein the default limitation is set based upon whether voice, video or information is being transmitted.

11. The system of Claim 1 wherein the transmitted and retransmitted signals are combined based upon the following equation:

$$M_n(L) \;^{\circ}\; M_n (L-1) + \Delta m_{n,\,L}$$

where: M is an accumulation of soft decision bit metrics resulting from rake processing of the signals, L is a number of the signal being retransmitted, n is a number of the bit within the packet of information being transmitted, Dm is an incremental, soft decision bit reception metric from a last transmission.

12. A multiple access wireless communications system comprising a transmitter, a receiver, a means for sending ARQ request signals from

the receiver to the transmitter, and a means for combining a retransmitted signal in response to the ARQ request signal with information from previously received signals to obtain an output signal.

13. A processing system within a multiple access wireless communications environment, comprising: a receiver receiving signals transmitted from a transmitter, the signals being retransmitted in response to an ARQ request signal sent from the receiver to the transmitter, a first processor to combine metrics from each received signal to produce a first processor output signal, the first processor output signal being input to an accumulator, the accumulator receiving the first processor output signal and a memory output signal and providing an accumulated output to the memory and a second processor, the second processor testing the accumulated output and sending the ARQ signal if the accumulated output does not surpass a poser threshold.

14. A method of communication across a wireless interface within a multiple access system of communication, comprising the steps of:

transmitting a signal representation of a packet of information;

retransmitting the signal representation of the packet of information;

receiving the signal representations of the packet of information; and

combining the transmitted signals with the retransmitted signals to obtain an output signal representation of the packet of information.

15. The system of Claim 14 including the further step of sending an ARQ signal from the receiver to the transmitter when the output signal is deemed to be unreliable, and sending the retransmitted signal in response to the ARQ signal.

16. The system of Claim 14 including the further step of determining when the output signal is not reliable when a default power limitation is not exceeded, the receiver sending an ARQ signal to the transmitter when the output signal is deemed to be unreliable, and the transmitter sending the retransmitted signal in response to the ARQ signal.

17. The system of Claim 14 wherein the signal representations received by the receiver have multiple metrics and including the step of combining the metrics using rake processing to produce a resulting received representation of the signal representation of the packet of information.

18. The system of Claim 17 further including the step of combining the resulting received representations using rake processing to produce the output signal representation of the packet of information.

19. The system of Claim 18 further including the step of combining the resulting received representations from each successive retransmission of the signal representation with a previously accumulated rake processed representation of the signal representation to produce a new accumulated rake processed representation of the signal representation, and wherein the new accumulated rake processed representation is the output signal representation of the packet of information.

20. The system of Claim 19 wherein the signal representation of the packet of information is retransmitted by the transmitter until the output signal representation of the packet of information is deemed reliable.

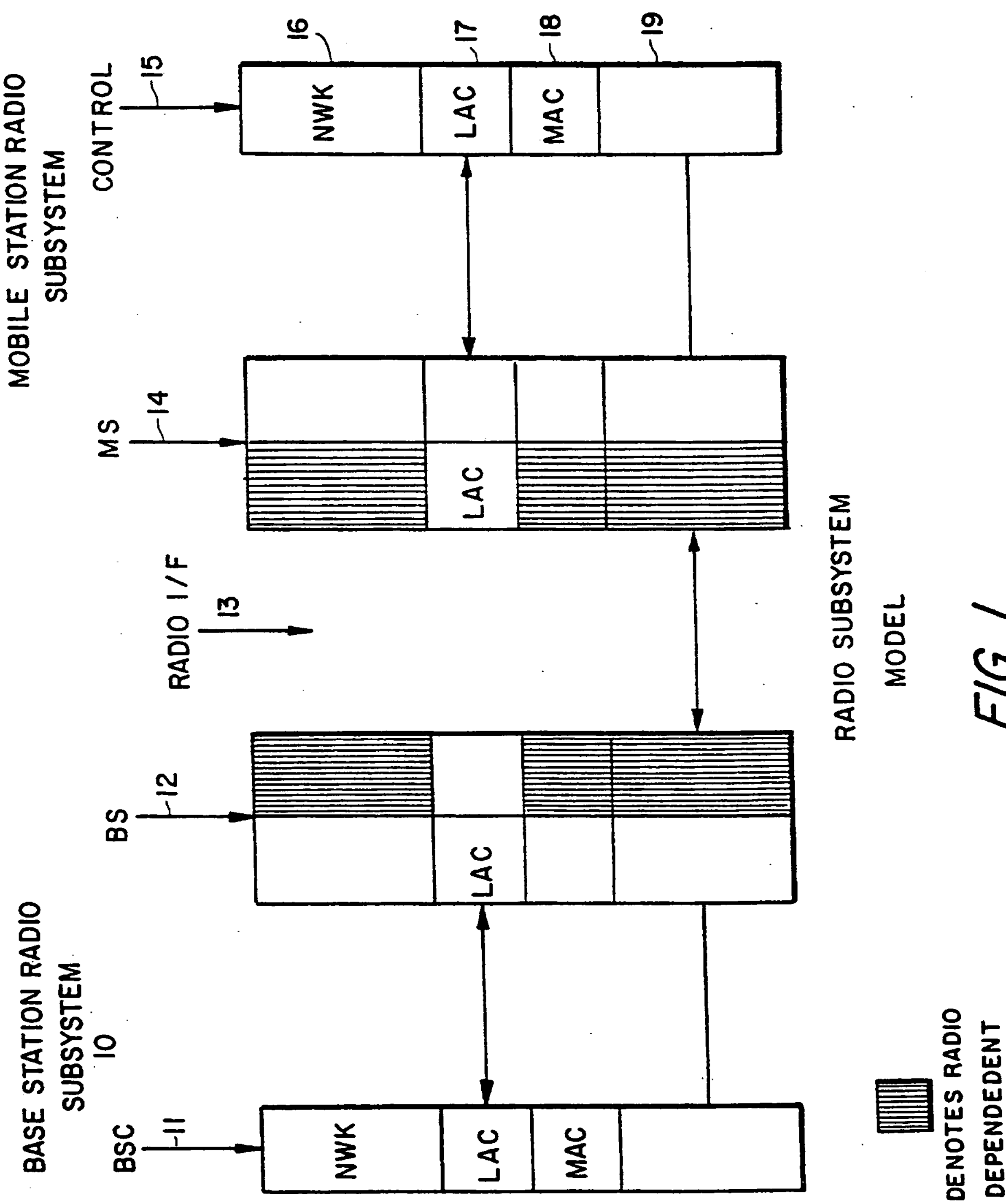
21. The system of Claim 19 wherein the signal representation of the packet of information is retransmitted by the transmitter an amount of times until the amount of times exceeds a default limitation of the amount of times allowed.

22. The system of Claim 21 further including a step of determining the default limitation based upon whether voice, video or information is being transmitted.

23. The system of Claim 14 wherein the transmitted and retransmitted signals are combined based upon the following equation:

$$M_n(L) \,^\circ\, M_n\,(L-1) + \Delta m_{n,\,L}$$

where: M is an accumulation of soft decision bit metrics resulting from rake processing of the signals, L is a number of the signal being retransmitted, n is a number of the bit within the packet of information being transmitted, Dm is an incremental, soft decision bit reception metric from a last transmission.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LAC
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13
BS
12
LAC
BASE STATION RADIO SUBSYSTEM
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BSC
11
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LAC
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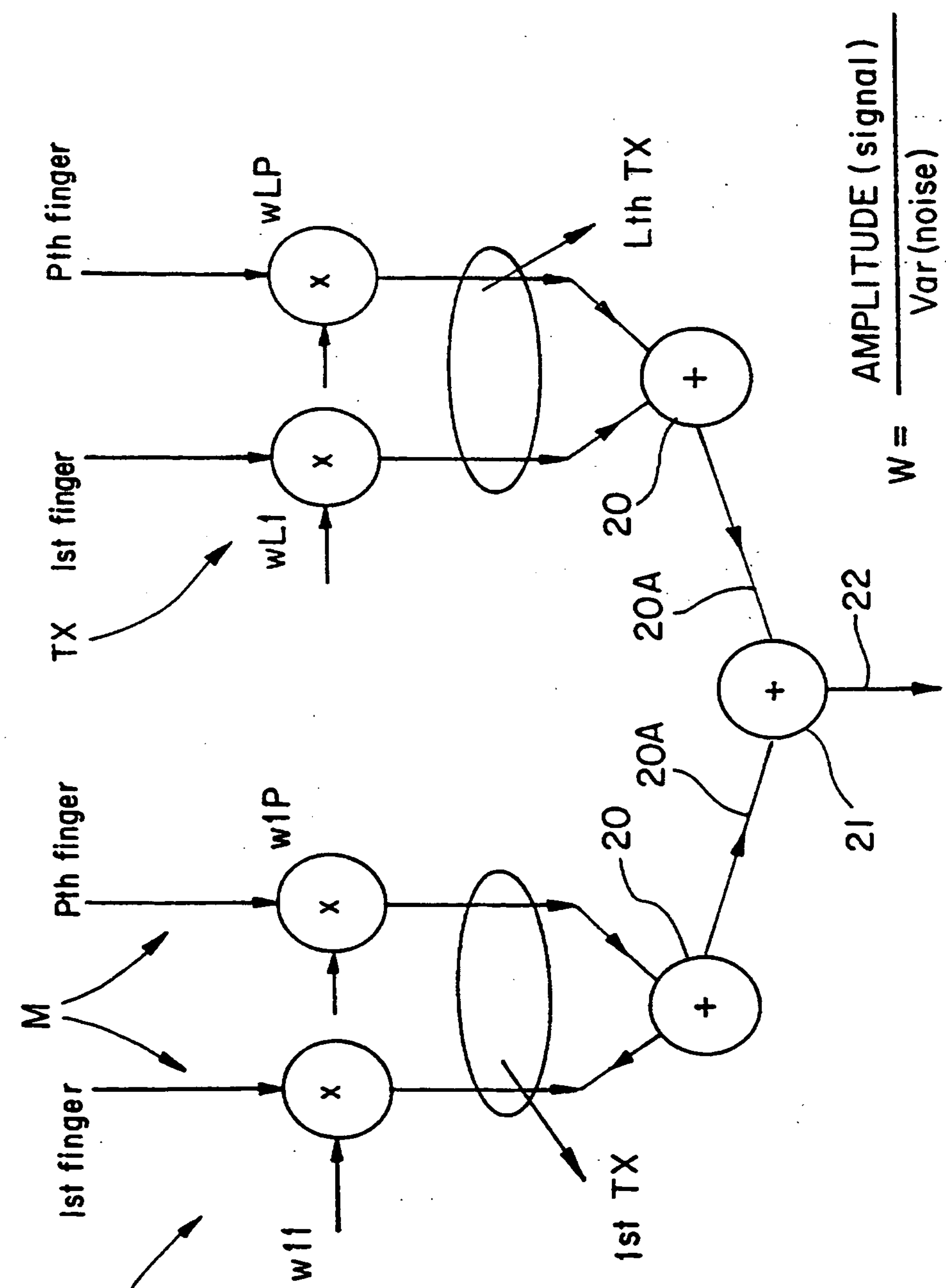
RADIO SUBSYSTEM MODEL
DENOTES RADIO DEPENDEDENT

FIG. 1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Pth finger
M
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w1P
1st TX
20
20A
21
22
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Pth finger
wL1
wLP
Lth TX
20
20A
W = AMPLITUDE (signal) / Var(noise)

FIG. 2

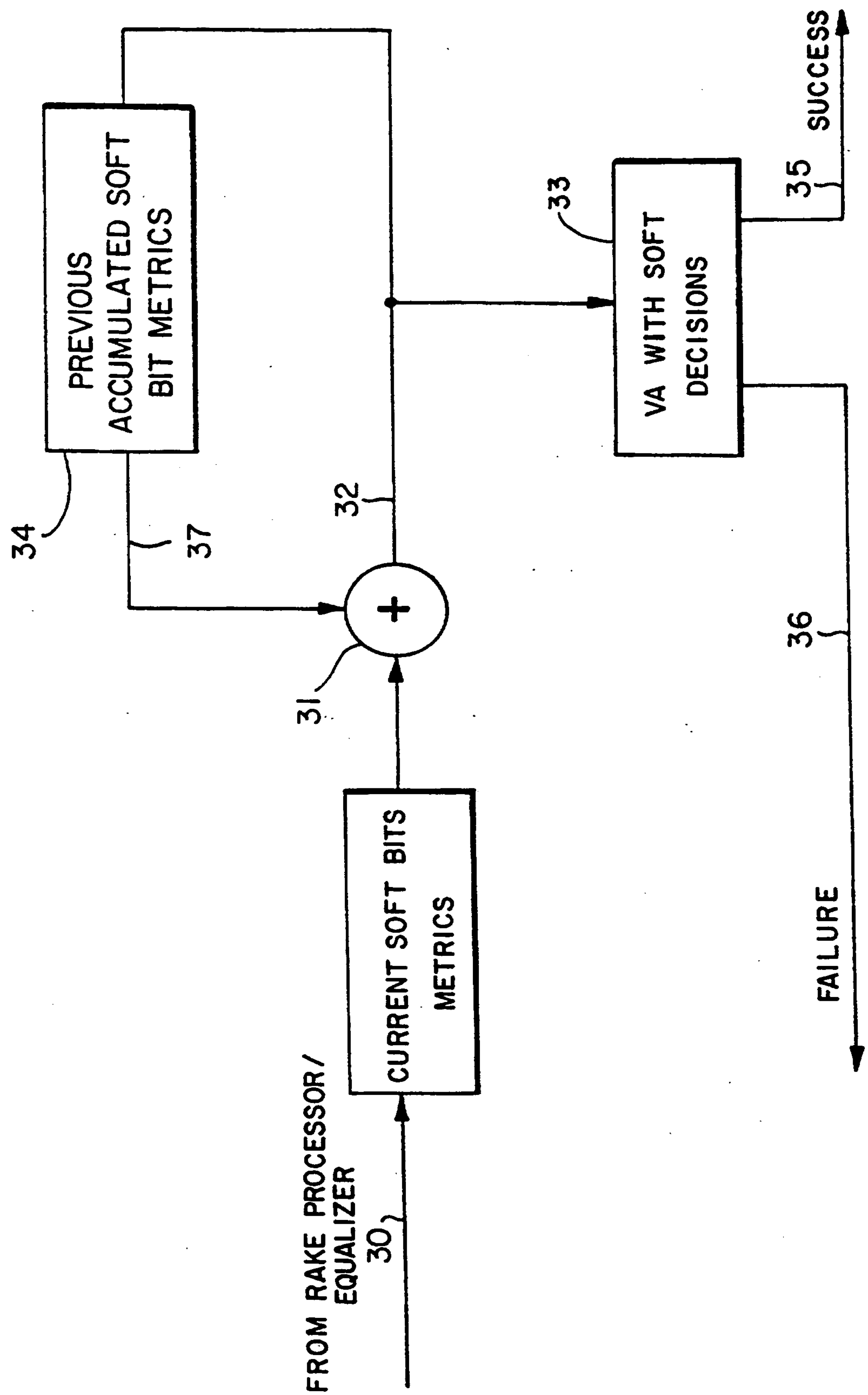
PREVIOUS ACCUMULATED SOFT BIT METRICS
34
37
32
+
31
VA WITH SOFT DECISIONS
33
35
SUCCESS
36
FAILURE
CURRENT SOFT BITS METRICS
FROM RAKE PROCESSOR/ EQUALIZER
30

FIG. 3

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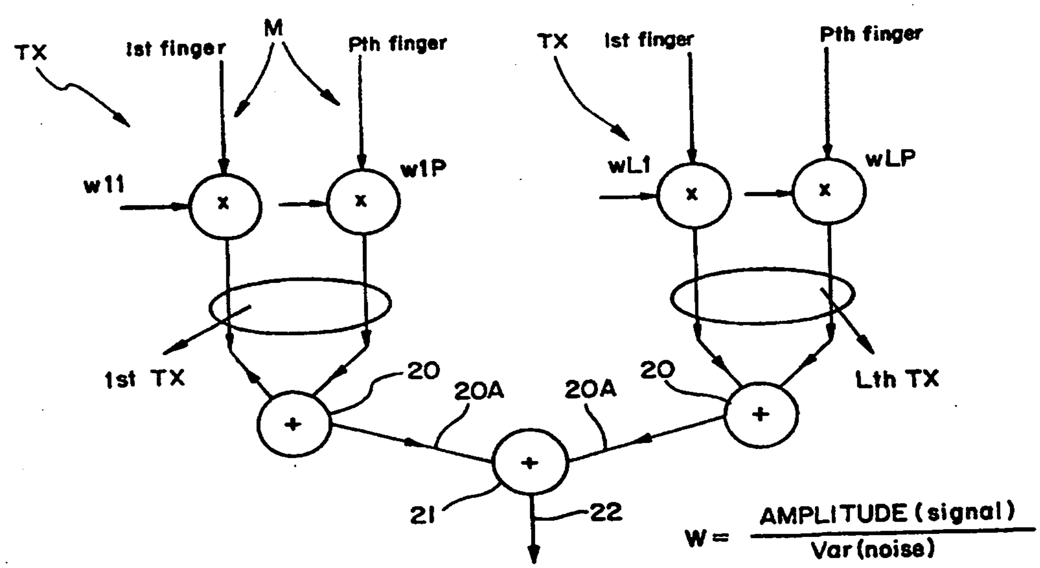

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A "hybrid" ARQ system within a multiple access wireless communications environment is provided for recombining ARQ retransmission signals with information obtained from corresponding previously failed transmissions of the same signal which had been sent and received within the air interface. Forward Error Correction (FEC) is implemented within an ARQ environment by using whatever acquired information has been previously obtained from RAKE processed transmitted and retransmitted signals and trying to correct the information by combining the signals and without retransmission.

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CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
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DE	Germany
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ES	Spain
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KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

INTERNATIONAL SEARCH REPORT

Int .tional Application No
PCT/US 98/18446

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L1/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BAKHTIYARI S ET AL: "PRACTICAL IMPLEMENTATION OF A MOBILE DATA LINK PROTOCOL WITH A TYPE II HYBRID ARQ SCHEME AND CODE COMBINING" PERSONAL COMMUNICATION - FREEDOM THROUGH WIRELESS TECHNOLOGY, SECAUCUS, NJ., MAY 18 - 20, 1993, no. CONF. 43, 18 May 1993, pages 774-777, XP000393297 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS see page 774, left-hand column, line 14 - line 27 see page 775, left-hand column, line 17 - line 33 ---	1-3, 13-15

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[X] Further documents are listed in the continuation of box C.

[ ] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 March 1999	29/03/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lazaridis, P

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INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/US 98/18446

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication where appropriate, of the relevant passages	Relevant to claim No.
X	KALLEL S ET AL: "SEQUENTIAL DECODING WITH AN EFFICIENT PARTIAL RETRANSMISSION ARQ STRATEGY" IEEE TRANSACTIONS ON COMMUNICATIONS, vol. 39, no. 2, 1 February 1991, pages 208-213, XP000225303 see page 208, left-hand column, line 1 - page 209, left-hand column, line 10	1-3, 13-15
A	M.J.MCTIFFIN, A.P. HULBERT, T.J. KETSEOGLOU, ET AL.: "Mobile Access to an ATM Network Using a CDMA Air Interface" IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, vol. 12, no. 5, June 1994, pages 900-908, XP002096626 see abstract see page 905, right-hand column, line 10 - page 907, left-hand column, line 5	1-23

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